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PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) FLAT SPRING

(71) We, EUROPEAN ATOMIC ENERGY COMMUNITY (EURATOM), of European Center Kirchberg, Luxemburg (Grand Duchy), do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a flat spring allowing substantially only a single direction of movement and is made from a membrane whose periphery is conveniently in the form of a circle or a regular polygon, the circumference or the centre of which is used to fix the spring to any support. The suspended object is attached to the centre of the membrane when the circumference is attached to a support and *vice versa*. The movement allowed by the spring is, substantially solely in the direction perpendicular to the plane of the membrane, to the exclusion of any other movement.

The known type of spring best satisfying these requirements is the annular spring described in the book "Feinmechanische Bauelemente" by Siegfried Hildebrand (Karl Hanser Velag, Munich 1968), page 458. This spring is made from a circular membrane formed with openings in the form of spiral slots. These openings weaken the membrane so that deformation is readily possible in the direction perpendicular to the plane of the membrane.

A disadvantage of this annular spring is that there is always a tangential rotational force in the case of every movement of the centre of the spring in relation to its periphery. This tangential rotational force can be compensated by combining two springs with opposite directions of rotation but in such cases the relationship between the restoring or return force and the axial displacement of the centre of the spring in relation to its periphery, is not linear.

The spring according to the invention meets the above requirements while obviating or reducing the disadvantages of known annular springs. It is characterised in that said membrane is cut out such that only strips of material symmetrically spaced from one another are left between its periphery and its centre, said strips being in the form of zig-zags or meandrous in a generally radial direction such that each strip crosses at least twice a straight line passing through the ends of the strip, the strips being connected together at the centre of the membrane, and the width of each strip being at least five times greater than the strip thickness.

The invention will be more readily understood from Figures 1 and 2, which are respectively a plan view and a profile view of one example of a spring according to the invention.

The drawings show a membrane 1 with its periphery in the form of a circle. The membrane may however have the form of any regular polygon, the circle being the limiting case of a polygon with an infinite number of sides. The membrane is cut away at 2 so as to leave just strips of material 3 of meandrous or zig-zag shape as shown in Figure 1, while having a generally radial direction. The strips 3, of which there are three, although more may be provided, meet at the centre 4 of the membrane which, if necessary, is formed with an aperture 5 for fixing an object which is required to be suspended or a support point. Similarly, apertures 6 for the same purpose may be formed in the periphery 7 of the membrane. For the above-described spring to be effective, the width of the strips 3 (shown in Figure 1) must be much greater (at least five times greater) than their thickness (see Figure 2). A spring consisting of an outer ring to which a number of radial coil springs are attached at the centre of the ring would not be suitable, for example, because the spring rate in the plane of the ring is much too low, so that it would be difficult to keep the central washer 4 correctly centred.

The spring according to this invention

allows movements of the centre 4 in relation to the periphery 7 only in the direction at right angles to the plane of the spring, i.e., in the two directions illustrated by the arrows 8 and 9 in Figure 2.

A linear relationship is observed between the restoring forces and the corresponding movements of the centre 4 with respect to the periphery 7. No rotational force can be detected during these movements.

The spring according to the invention has the following properties:

The spring rate (displacement force/displacement length) is small in only one direction, which is the perpendicular to its plane.

The spring rate in all the coplanar directions of the spring is large.

The restoring force on rotation through a small angle is high.

In the event of a movement of the suspended object in the direction at right angles to the spring plane, there is no displacement in the spring plane.

The spring rate remains constant over a very wide range of deformation (in the permitted direction), i.e., the curve representing the restoring force against displacement is a straight line.

Centring of the movable part is maintained during movement.

WHAT WE CLAIM IS:—

1. A flat spring allowing substantially only a single direction of movement, the spring being made from a membrane, the periphery and the centre of which serve respectively for fixing the spring and an object to be suspended from the spring which object is required to move in the direction perpendicular to the plane of the said membrane, characterised in that said membrane is cut out such that only strips of material symmetrically spaced from one another are left between its periphery and its centre, said strips being in the form of zig-zags or meandrous in a generally radial direction, such that each strip crosses at least twice a straight line passing through the ends of the strip, the strips being connected together at the centre of the membrane, and the width of each strip being at least five times greater than the strip thickness.

2. A flat spring according to claim 1, characterised in that there are at least three of said strips.

3. A flat spring according to claim 1 or claim 2 in which the periphery of the membrane is in the form of a circle or a regular polygon.

4. A flat spring substantially as described with reference to, and as shown in, the accompanying drawings.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig. 1.

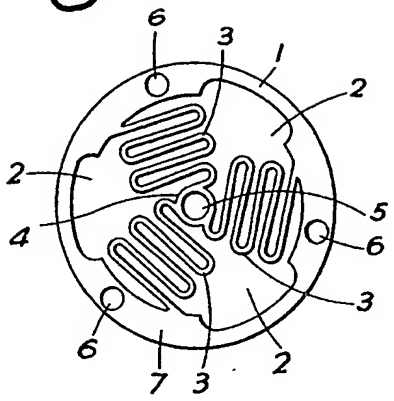

Fig. 2.